THURSDAY, DECEMBER 13, 1883

PROFESSOR STOKES' WORKS

Mathematical and Physical Papers. By G. G. Stokes. (Cambridge University Press. Vol. I., 1880; Vol. II., 1883.)

THIS is the age of Reprints of the works of great living men, even in an hourly growing subject like Science. The pseudo-scientists have long been accustomed to galvanize into life again, for a few brief moments, their defunct prelections by collecting them in a volume with some catching title. But the real men of science are now building, during their life-time, each his *monumentum ære perennius, regalique situ Pyramidum altius.* Von Helmholtz and Kirchhoff have collected and reissued their scattered masterpieces. Clausius has joined one large series of his works into a connected treatise. At home Sir W. Thomson has given us a grand collection, *Electrostatics and Magnetism,* and the rest of his papers are to appear in a series of volumes, of which one is already before the public. But, heartily as we welcome all these splendid volumes, here is something at least as good as the best of them, and *much more imperatively required.*

There can be but one opinion as to the value of the collection before us, and (sad to say) also as to the absolute *necessity* for it. The Author, by common consent of all entitled to judge, takes front rank among living scientific men as experimenter as well as mathematician. But the greater part of his best work has hitherto been buried in the almost inaccessible volumes of the *Cambridge Philosophical Transactions,* in company with many other papers which deserve a much wider circulation than they have yet obtained. Stokes' well-deserved fame was thus practically secured by means of a mere fraction of his best work. And another inconvenience, which will *now* have some chance of being repaired, has arisen from the same cause. Science demands, at every instant, the solution of certain definite problems each suggested by the last-preceding advances:—and hosts of eager votaries are at work upon them. What is done as it were in a corner is thus sure to be done again:—done, even if not so well done; and this at the expense of unnecessary labour on the part of the second worker, who thus obtains the (temporary) award of the whole credit; while the entire process tends to the retardation of scientific progress.

The present publication will effect a very remarkable amount of transference of credit to the real author, from those who (without the possibility of suspicion of *mala fides*) are at present all but universally regarded as having won it. Two or three years ago, only, the subject for a Prize Essay in a Continental scientific society was *The nature of unpolarized, as distinguished from polarized, light.* But, all that science is even yet in a position to say, on this extremely curious subject, had been said by Stokes *thirty years ago* in the *Cambridge Philosophical Transactions.*

The malady, though grave, is simple, the cure easy. Every Society, whose Memoirs are worthy of appearing in print, ought to consider itself bound to disseminate them as widely as possible. Every University, every public library of any importance, alike in Europe and in America, should be regarded as a centre for such a purpose. The cost of the necessary additional copies should be regarded by a Society as a trifle compared with the priceless advantage of *placing* its own publications where they will be freely accessible to all who care to consult them.

And this altogether independent of the question of *exchange,* which can hardly be expected from a University, but which, in our own experience, is gladly (even eagerly) granted by almost every scientific Society worthy of the name.

Physical and Mathematical researches are the best record of the living intellectual progress of the day, and ought not to be made artificially scarce or dear. It is mere pandering to wealth and vanity which is displayed in advertisements such as "Impression strictly limited to 65 (numbered) copies. After these are printed, the type will be broken up (in presence of witnesses) and the plates destroyed."

Such advertisements are possible only in a world in which Sir Gorgius Midas, and others who have "struck ile," are the willing victims of those who prey on their selfishness, luxury, and ignorance. Education will, it is to be hoped, in time do away with such things.

To give anything like an adequate account of even one of the longer papers in these two volumes would require an entire article. And, when written, the account would in most cases be practically unintelligible to the general reader; while quite unnecessary for the student, who will of course prefer to repair to the fountain-head itself, now at last rendered easy of access.

Prof. Stokes has wisely chosen the chronological order, in arranging the contents of the volumes. Such a course involves, now and then, a little inconvenience to the reader; but this is much more than compensated for by the insight gained into the working of an original mind, which seems all along to have preferred a bold attack upon each more pressing scientific difficulty of the present, to attempts at smoothing the beginner's road into regions already well explored. When, however, Prof. Stokes does write an elementary article, he does it admirably. Witness his *Notes on Hydrodynamics,* especially that entitled *On Waves.*

Before that article appeared, an article as comprehensive as it is lucid, the subject was almost a forbidden one even to the best student, unless he were qualified to attack the formidable works of Laplace and Airy, or the still more formidable memoirs of Cauchy and Poisson. Here he finds at least the main points of this beautiful theory, disencumbered of all unnecessary complications, and put in a form intelligible to all who have acquired any right to meddle with it. It is quite impossible to tell how much real good may be done by even *one* article like this. Would there were more such! There are few, even of the most gifted men, who do not occasionally require extraneous assistance after the earlier stages of their progress:—all are the better for it, even in their maturer years.

The contents of these two volumes consist mainly, almost exclusively, of papers connected with the *Undulatory Theory of Light* or with *Hydrodynamics.* On the

former subject at least, Stokes stands, without a living rival, the great authority. From the *Aberration of Light*, the *Constitution of the Luminiferous Ether*, the full explanation of the singular difficulties presented by *Newton's Rings*, to the grand theoretical and experimental treatise on the *Dynamical Theory of Diffraction*, we have a series of contributions to this branch of optics which, even allowing for improved modern surroundings, will bear comparison with the very best work of Newton, Huyghens, Young, or Fresnel in the same department.

Specially remarkable among the Hydrodynamical papers is that on *Oscillatory Waves*, to which a very important addition has been made in the reprint. The investigation of the "profile" of such a wave is here carried to a degree of approximation never before attempted.

Besides these *classes* of papers we have the very valuable treatise on *Friction of Fluids in Motion, and on the Equilibrium and Motion of Elastic Solids*. This was Stokes' early masterpiece, and it may truly be said to have revolutionized our knowledge on the subjects it treats. To mention only one point, though an exceedingly important one, it was here that for the first time was clearly shown the error of assuming any *necessary* relation between the rigidity and the compressibility of an elastic solid, such as had been arrived at from various points of view by the great Continental mathematicians of the earlier part of the present century.

Of the few purely mathematical papers in the present volumes the most important is the well-known examination of the *Critical Values of the Sums of Periodic Series*, a subject constantly forced on the physicist whenever he has to treat a case of discontinuity.

We need not say that the printing of these volumes is all that could be desired: the name of the Pitt Press is a sufficient guarantee. But the introduction, for the first time, of a *solidus* to save "spacing" and space in the printing of mathematical formulæ, was a bold step on the part of Prof. Stokes:—since amply justified by the testimony of the readers of the first of these volumes, and still more by its almost immediate adoption by thoroughly scientific as well as practical men, such as the Editors of what we still feel inclined to call by the well-known name of *Poggendorff's Annalen*. P. G. TAIT

ROYAL ENGINEER PROFESSIONAL PAPERS

Professional Papers of the Corps of Royal Engineers. Edited by Major R. H. Vetch, R.E. Vol. VIII. 1882, 214 pp., 39 pl. (London: Stanford, 1883.)

SO many essays were contributed to these papers in 1882 that it was found necessary to publish two volumes for that year. This is a healthy sign of the interest taken by the Corps as a whole in their profession. Vol. VII. was devoted entirely to permanent fortification, a purely professional subject; whilst Vol. VIII. contains eleven papers, several of which are of general interest. This volume must have been an expensive one to get up, as it contains thirty-nine plates, some of them pretty large: the size and expense of the volume might have been considerably reduced if the contributors had prepared their plates in a more convenient shape; *e.g.* one plate, a mere genealogical table, and not really a large one (Appendix I.), has eight cross folds and one longitudinal one; this could easily have been much compressed.

Paper 3 is a careful and well got up study of the "Campaigns of Lord Lake against the Marattas," 1804-6 (92 pp., with nine plates), which will be read with interest by all students of military campaigns. A good illustration of the difficulty of ascertaining the truth about events of eighty years back occurs in the verification of the site of the "battle of Delhi" (1803); the supposed site is actually marked by a pillar with inscription; but, after careful collation of contemporary surveys and reports of marches, the author decides *against the site marked by the pillar*.

Paper 8 is an interesting account of the "Triangulation of Northern Afghanistan" carried out during the late war. It is worth notice here that the introduction of the heliograph into army signalling has thrown a difficulty in the way of the use of the heliotrope for survey (in the field), from the liability of confusing the signals; but there seems little doubt that in the future the army heliograph stations could be used for the survey, and be an assistance instead of a hindrance to the survey. The general result of the altitude observations has been to throw doubt on the efficiency of the aneroid, a result much to be regretted. The refraction, which in India is about ·067 of the contained arc, was found to amount to ·08 of the same in the Afghan hills; an unusual result, as refraction commonly decreases with altitude.

An interesting paper (No. 9), on "Organic Compounds in the Sun," by Capt. Abney (read in 1881), gives a popular *résumé* of the subject (up to 1881), ending with the author's spectroscopic researches showing the presence of hydrocarbons in the sun and probably in space itself; this last raises curious questions as to the constitution of the ether; can space be really full of hydrocarbons? This paper has suffered rather by the delay in publication.

Perhaps the most important (military) paper is No. 10, on "Railways for Military Communications in the Field." The author shows that the early attempts at introducing railways on field service all failed to be of much practical use from their unsuitability to the conditions, the first of which is lightness and portability of both rails and rolling-stock, and it is just herein that the English railways fail most, being amongst the heaviest in the world. A light railway largely used in the United States, which has been laid at the rate of four miles a day, is favourably mentioned. After recapitulating the various schemes which have been tried or proposed, the author gives his conclusions as to the conditions for a military railway; among the most important of these are that the gauge should be 2½ feet, the rails 10 lbs. per foot, and the line double. It is clearly impossible for any country to keep a *large* stock of railway plant specially for service: now it so happens that this 2½-foot gauge is already in use to some extent in Europe, so that the requisite plant could probably be obtained at short notice in Europe. In India, however, the metre-gauge is so largely in use that field railways in or near India will probably for many years perforce be of metre-gauge. The field railway laid for the use of the British army in South Afgahnistan (1879-80) is not mentioned; this railway was laid for a great